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SEMI-ANNUAL PROGRESS REPORT

ON

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COMPUTATION OF BROADBAND MIXING NOISE FROM TUBOMACHINERY

PERIOD COVERED BY THIS REPORT

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As reported before we are to develop a theory of broadband mixing noise starting with the k-ϵ turbulence modelling equations. We have chosen to concentrate on the free shear flows because experimental data is available for comparison with prediction. The model equations are highly nonlinear. They can be solved computationally in the form of direct numerical simulation. We, however, do not propose to do so instead we are to model the large scale structure of the flow from which we can determine the fine scale turbulence energy k statistically. With k known the noise radiated can be computed by solving the appropriate nonhomogeneous problem. We have now developed a statistical model of the large turbulence structures of the shear layer flow. At low Mach number the effect of compressibility on the large turbulence structures is unimportant. Compressibility is important only in the noise generation process. During the coming year we will estimate k generated by the large turbulence structures. Once this step is completed we will move on to the step of noise prediction.

As a part of our research effort we are to study the best way to calculate the radiated noise. We presume that this step may have to be carried out computationally. That is, we might have to employ finite-difference or other computational methods in solving the sound propagation or transmission problem. Because of this possibility we are looking at the feasibility of computing acoustic radiation by finite-difference schemes. The medium described by the finite-difference approximation of the Euler's equation has characteristics which may differ considerable from those of the original partial differential equations. These differences require a re-examination of the influence of radiation boundary conditions, dispersion effects and non-isotropic directivity effects and solid wall surface boundary conditions on the computed results. There are intrinsic questions in computational acoustics which are not considered by present day computational fluid dynamics theory and methods. We have completed a study of the effects of dispersion intrinsic in finite-difference methods on the computation of propeller noise. The results of this investigation will be presented at the forthcoming AIAA 13th Aeroacoustics Conference in a paper entitled "Discretization errors inherent in finite-difference solution of propeller noise problems." In the coming year we will spend a modest amount of effort in developing better methods for solving computational acoustics problems which would help our goal of calculating broadband mixing noise.

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